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NDE Techniques for Wood Structures

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Abstract

Several techniques have been investigated for use in assessing wood members in structures. Pick- or probing-type of tests, sound transmission characteristics, and vibration response have all been investigated for use in evaluating wood structures. This paper reviews the underlying principles that serve as a basis for use of these techniques.

Introduction

Nondestructive evaluation (NDE) of materials is the science of identifying the physical and mechanical properties of a piece of material without altering its end-use capabilities. Such evaluations rely on nondestructive testing (NDT) techniques to provide accurate information pertaining to the properties and performance of the material in question.

Several techniques are available and used by inspectors and engineers to aid in the evaluation of wood structures. A comprehensive report that discusses these techniques and applications to wood members in structures has recently been published (Ross and Pellerin 1994). This paper presents a summary of that publication, with an emphasis on use of these techniques for in-place assessment.

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Nondestructive Testing Techniques

Several organizations have published research results on the use of NDT techniques for in-place evaluation of wood members. The following summarizes research conducted on the use of several NDT techniques for such evaluations.

Static Bending Techniques

Measuring flexural modulus of elasticity (MOE) by static bending techniques has been successfully employed to grade lumber by using machines that approximate simply-supported boundary conditions. Such machines consistently maintain these conditions. However, an in-place environment yields boundary conditions that may vary considerably in even the simplest stucture. Consequently, application of this technique for in-place assessment of wood members has been limited.

Abbott and Elcock (1987) developed an in-place NDT technique for measuring the stiffness of in-place poles. A bending load was applied to the individual poles above the ground line. Load and resulting deflections were recorded and used to compute flexural stiffness. From these measurements, inferences pertaining to pole strength were made.

Transverse Vibration Techniques

Transverse vibration techniques are also significantly influenced by boundary conditions. Most researchers conducting laboratory studies with this technique devote considerable time to insuring that simple end conditions are attained. As previously discussed, such conditions frequently do not exist with wood members in structures. Consequently, use of this technique has also been limited for in-place evaluations.

Murphy and others (1987) developed a technique based on transverse vibration NDT techniques for evaluating wood poles. Their technique involved measuring the vibrational response of a pole after it is tapped by a rubber mallet. Resonant frequency of the pole was identified and used to infer pole strength.

Stress Wave Techniques

Stress wave NDT techniques have also been investigated by researchers to assess wood members in structures. The influence of boundary conditions on speed-of-sound transmission measurements has been shown to be significantly less than that for static bending or transverse vibration techniques. Thus, many researchers have examined stress wave techniques for in-place assessment of wood members.

Other NDT Techniques

Simple mechanical tests are frequently used for in-service inspection of wood members in structures. For example, sounding-, pick-, or probing-type tests are used by inspectors of wood structures to indicate the condition of a structural member. The underlying premise for the use of such tests is that degraded wood is relatively soft and will have a low resistance to probe penetration.

A quantitative test based on the same underlying premise was developed by Talbot (1982). His test differed from the probing-type test in that instead of evaluating probe penetration resistance, Talbot examined withdrawal resistance of a threaded probe, similar to a wood screw, inserted into a member. Talbot believed that a correlative relationship between withdrawal resistance and residual strength should exist and would be relatively easy to implement. To determine if such a relationship existed, he conducted an experiment using several small Douglas-fir beams that were in various stages of degradation as a result of exposure to decay fungi. Prior to testing to failure in bending, probe withdrawal resistance was measured at the neutral axis of the beams. Bending strength and corresponding probe resistance values were then compared. Results indicated that a useful relationship does exist.

Appendix

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